



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

July 23, 2010

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Explanation of Error in Table 4-3 (Percentage Reductions in Non-PRB PM₁₀ Light Extinction Required to "Just Meet" the NAAQS Scenarios Based on Measured Light Extinction) of the Final Urban Focused Visibility Assessment

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TO: PM NAAQS Review Docket (EPA-HQ-OAR-2007-0492)

I have realized that between the second version (January 2010) and final version (July 2010) of the Urban Focused Visibility Assessment (UFVA), I directed the UFVA software programmer to make an erroneous change to the computer code that performs rollback calculations of PM₁₀ light extinction levels representing national ambient air quality standards (NAAQS) scenarios based on PM₁₀ light extinction as the indicator. The error had the effect of removing the policy relevant background (PRB) PM_{10-2.5} concentrations from the calculations of policy relevant background hourly PM₁₀ light extinction. As a result, the entries in Table 4-3 of the final version of the UFVA completed on July 22, 2010, are not strictly correct. In general, the required reductions shown in that table are slightly smaller than they should be. The only other results presented in the final UFVA document that were affected by this error were the following:

- Figure 4-2 (a graphical representation of the values presented in Table 4-3)
- Table 4-7 (listing the percentage of days above Candidate Protective Levels after rollback)
- The upper graphics in Panels (a) through (r) of Appendix F (box plots of PM₁₀ light extinction after meeting NAAQS scenarios defined in terms of a PM₁₀ light extinction indicator).
- Figure 4-3(a) (a copy of Panel (d) of Appendix F)¹

¹ Note that Figure 4-6 in the second draft Policy Assessment Document (PAD) also is a reproduction of Panel (d) of Appendix F. However, the graphic used in the PAD was taken from the second draft of the UFVA and, thus, was not affected by this error because the rollback software was correct at the time the second draft UFVA was produced.

The effect on these tables and figures was judged too negligible to warrant regenerating them for the final version of the UFVA.

Description of the Error

The rollback process described in Section 4.1.4 of the UFVA for NAAQS scenarios based on a PM_{10} light extinction indicator requires an estimate of hourly PM_{10} light extinction due to PRB concentrations of all light-extinguishing particulate matter, because only the portion of light extinction due to concentrations of particulate matter above the respective PRB levels is assumed to be reducible by a control strategy aimed at meeting the NAAQS. This hourly PRB PM_{10} light extinction should be calculated using the original IMPROVE algorithm applied to estimates of the hourly PRB concentrations of the five components of $PM_{2.5}$ produced by the UFVA modeling, the time-invariant estimates of PRB $PM_{10-2.5}$ from Table C-2 of the UFVA, and hourly relative humidity. For the January 2010 second draft UFVA, this was done correctly. However, while giving instructions to the software programmer for adapting the process described in Section 4.1.4 to deal with NAAQS scenarios based on hourly $PM_{2.5}$ mass for purposes of the second draft PAD, I inadvertently directed him to drop the $PM_{10-2.5}$ concentration term from the calculation of PRB PM_{10} light extinction in the software for the rollback process for the light extinction indicator scenarios. The erroneous software for light extinction NAAQS scenarios was never used for any second draft PAD element, because that draft focused on other indicators. However, when this software was re-executed for the final UFVA, the tables and graphics listed in the first paragraph of this memo were re-generated using the incorrect version of the formula for PRB PM_{10} light extinction.² The error was realized too close to the already-extended target for public release of the final UFVA for the error to be corrected. Because the table values and graphics from the second draft UFVA were unsuitable in that they reflected the SANDWICH error and because the effect of the PRB error on the values and graphics was known to be negligible, EPA staff chose to incorporate the PRB-error-affected graphics into the final UFVA document.

Size of the Error

The size of the error has been assessed in two ways, a simple case study illustration and point-by-point comparisons of two available sets of 15-area results that differ only in respect to the presence or absence of the PRB-related error.

Case Study: Dallas

According to Table C-2 of the UFVA, PRB $PM_{10-2.5}$ for Dallas is 8.5 ug/m^3 , a little higher than the midpoint of the range across all 15 areas. This would translate to a light extinction contribution of 5.1 Mm^{-1} , when multiplied by the 0.6 factor for $PM_{10-2.5}$ in the IMPROVE algorithm. According to Table C-4, the average of daylight hour PM_{10} light extinction (including

² It was necessary to regenerate all the UFVA graphics for the final version because all had been affected by the SANDWICH processing error. See Memo, "SANDWICH-related Correction to the Urban-Focused Visibility Assessment Data File, as Used for the Final Document," Philip A. Lorang, July 23, 2010.

the contribution from $PM_{10-2.5}$) for Dallas is 8 Mm^{-1} . Thus, the correct estimates for hourly PRB PM_{10} light extinction in Dallas will center around 8 Mm^{-1} , and the incorrect estimates that exclude the effect of $PM_{10-2.5}$ will center around 3 Mm^{-1} . The 90th percentile daily maximum PM_{10} light extinction design value for Dallas is 184 Mm^{-1} . Consider the most stringent NAAQS scenario level of 64 Mm^{-1} . To reach this level starting from a design value of 184 requires a reduction in non-PRB PM_{10} light extinction that is either 66.3 percent or 68.2 percent, depending on whether PRB is assumed to be 3 or 8 Mm^{-1} .³

Point-by-Point Comparisons

We have available two sets of 15-area UFVA current conditions and rollback results that differ only in respect to the presence or absence of the PRB-related error. The first is the set of modeling outputs used for the January 2010 second draft UFVA. The second is the set of outputs for a “practice” run made after the PRB error was introduced but before the SANDWICH error was corrected. Both of these sets reflect the SANDWICH error, but the SANDWICH error should not much affect the differential effect caused by the PRB-related software error.

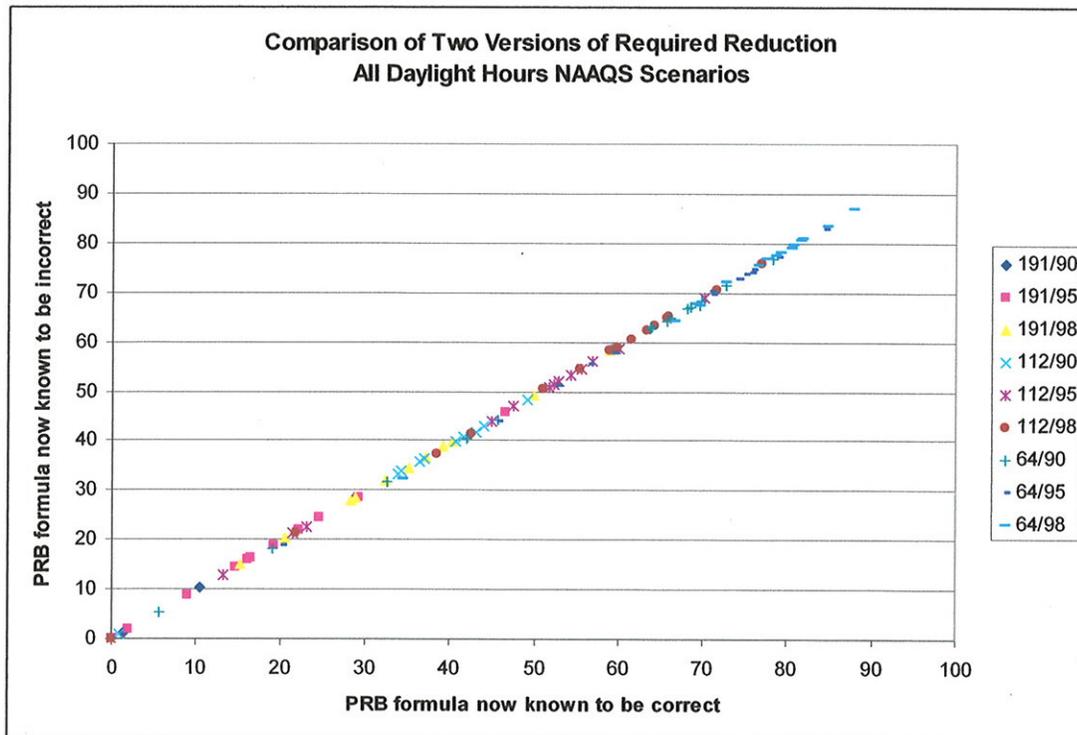
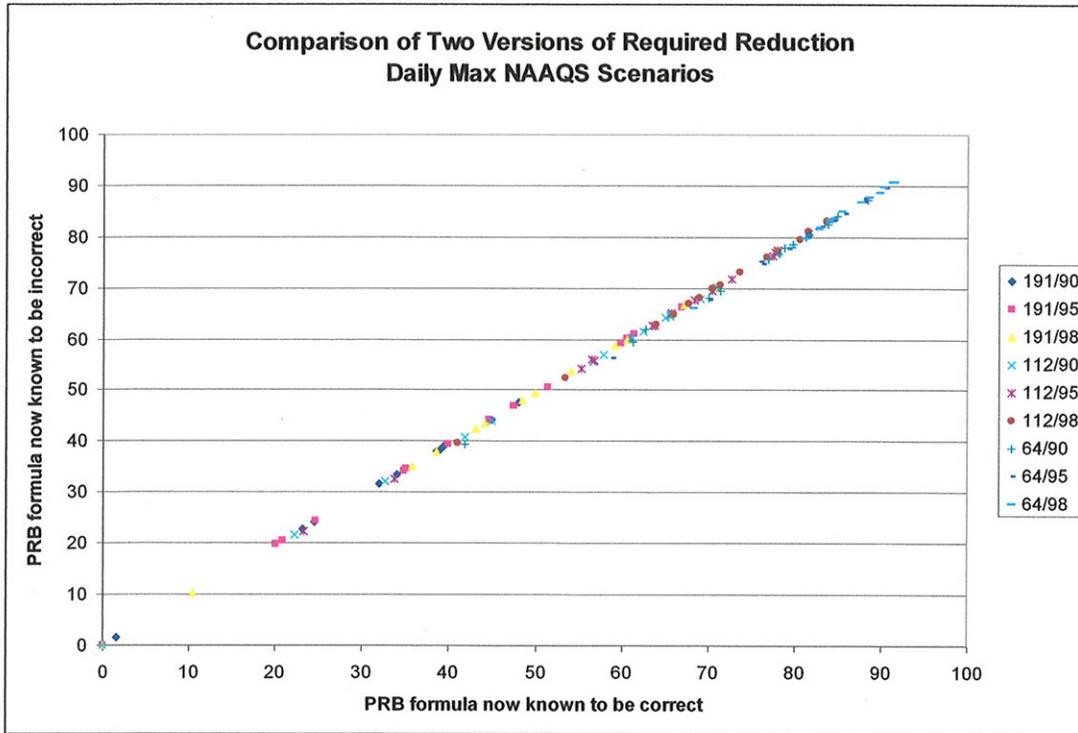
The two figures below compare the estimated required percentage reductions from these two sets of modeling output. The first figure is for NAAQS scenarios based on daily maximum 1-hour daylight PM_{10} light extinction, and the second is for NAAQS scenarios based on all daylight hours. The largest deviation from either of the 1:1 lines is 2.6 percentage points, for a daily maximum case where the percentage reduction from the PRB formula now known to be correct was 59 percent.

Figure 4-2 of the UFVA is a graphical representation of the values in Table 4-3, and so errors of up to about 2.6 percentage points in Table 4-3 also affect it.

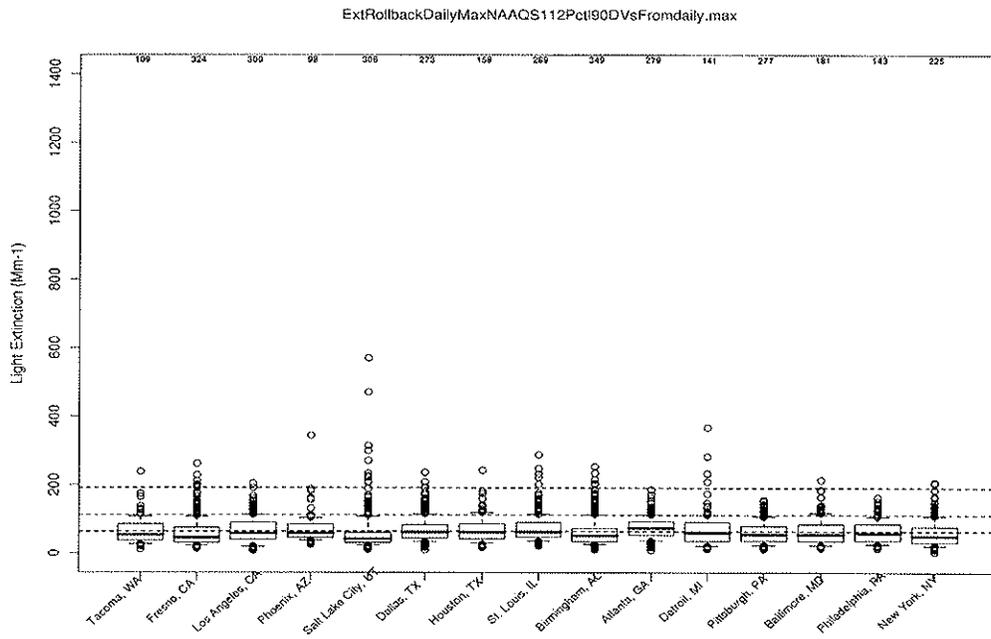
Panels (a) through (r) of Appendix F (and Figure 4-3) of the UFVA are box plots of PM_{10} light extinction levels after rollback to meet NAAQS scenarios. By design, rollback forces the design value to meet the NAAQS level target regardless of the level of PRB light extinction. However, in the UFVA, modeling each hour can have a different level of PRB PM_{10} light extinction, both in absolute and relative terms. Thus, while an error in the PRB formula will not prevent rollback from forcing the design value to meet the target NAAQS level, it can cause differences in how individual hourly values are adjusted. It is likely some points in the post-rollback box plots have shifted very slightly as a result of the PRB-related error. However, this movement necessarily must be very small and is imperceptible when viewing the box plots. For example, below are two versions of the same scenario graphic used in Figure 4-3. Both include the SANDWICH error. The first is the version that actually was used in the January 2010 second draft UFVA (based on the PRB formula now known to be correct) and the second is from the

³ Taking into more detailed account of hourly concentrations, Table 4-3 of the final UFVA indicates a required reduction of 69 percent for this scenario, based on the erroneous estimates of PRB PM_{10} light extinction that were too low.

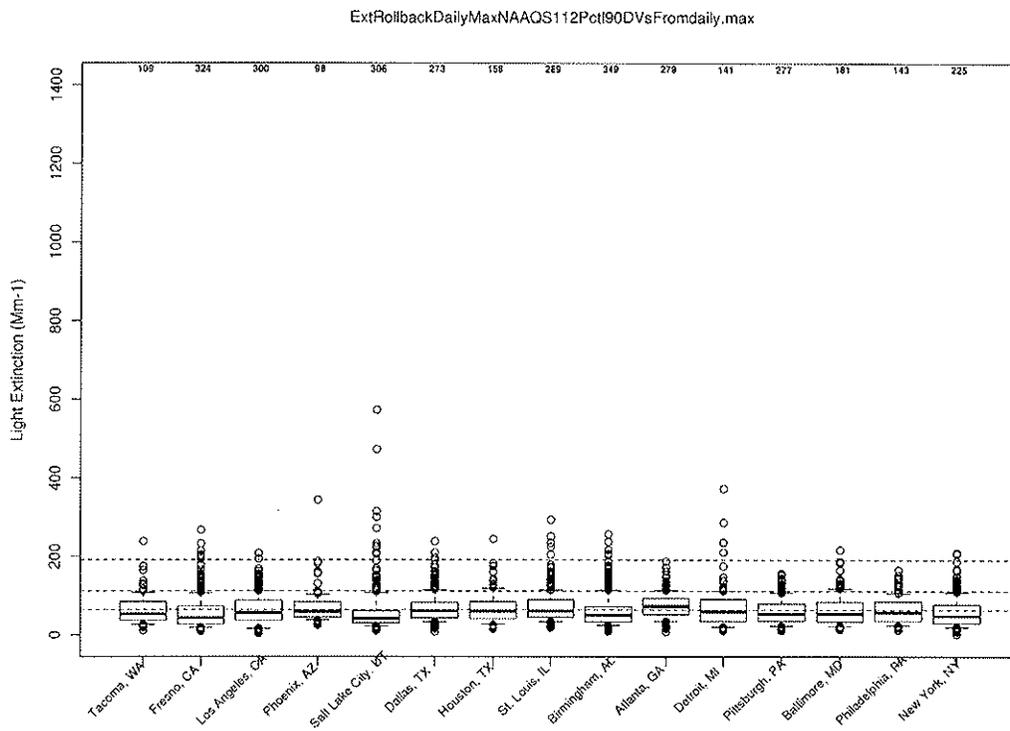
“practice” run mentioned above (based on the PRB formula now known to be incorrect). As expected, the two are indistinguishable to the eye.



Graphic Figure 4-3 from Second Draft UFVA



Version of Graphic Figure 4-3 Incorporating Error in PRB PM₁₀ Light Extinction Formula



Finally, Table 4-7 of the UFVA – Percentage of days across 3 years (two in the case of Phoenix and Houston) with maximum 1-hour daylight PM light extinction above CPLs when “just meeting” the NAAQS scenarios – reports the percentage of data points that are above the three horizontal CPL lines in box plot figures like Figure 4-3. It is conceivable that some points were shifted enough by the error to make the difference between being above or below one of the lines and, thus, Table 4-7 may have been affected by the PRB formula error. However, the effect should be quite rare and small. A shift of a single data point relative to a CPL line would change the percentages shown in Table 4-7 by one percentage point in the case of Phoenix which has only 98 data points and by as little as about 0.3 percentage points in some areas with about 300 data points. Such changes would not affect the conclusions drawn in the final UFVA based on Table 4-7.